Biomass cofiring at Allegheny Energy Supply Company

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Allegheny Energy Supply Co., LLC has developed two cofiring demonstrations under a Cooperative Agreement with the National Energy Technology Laboratory (NETL) of the US Department of Energy (USDOE). These demonstrations are at the Willow Island Generating Station and the Albright Generating Station; both are located in West Virginia. Both demonstrations resulted, in part, from the West Virginia Governor's Task Force on Cofiring. The Electric Power Research Institute (EPRI) provided partial support for the testing at Albright Generating Station through its Cooperative Agreement with USDOE (NETL and the Office of Energy Efficiency and Renewable Energy).

The Willow Island #2 boiler is a 188 MWe cyclone unit equipped with separated overfire air as a low NO_x firing method. The Albright #3 boiler is a 150 MWe tangentially fired pulverized coal boiler, also equipped with separated overfire air as a means for reducing NO_x emissions. These are the first units to pursue cofiring for NO_x reduction simultaneously with employing separated overfire air. Both cofiring and separated overfire air techniques rely upon modifying local stoichiometric ratios for NO_x reduction; cofiring also relies upon flooding the base of the flame, or ignition area, with volatiles to increase fuel staging within the boiler. One primary technical question addressed by these demonstrations, then, is the extent to which cofiring and separated overfire air work synergistically to reduce NO_x, and the extent to which they compete with each other—rather than complement each other—to drive the same mechanisms. Because the Willow Island project involved a triburn with tire-derived fuel (TDF), its influence was also identified and elucidated. The synergistic effects of sawdust and TDF were also considered. During some tests TDF and sawdust were trifired; during other tests sawdust alone was cofired with coal.

The simultaneous demonstrations of cofiring in a cyclone boiler and in a tangentially fired boiler, both of essentially equivalent capacities and both firing Pittsburgh seam coal, permits an analysis of the influence of firing method on the applicability of cofiring as a NOx reduction technique. The designs of the cofiring systems and the cofiring demonstrations further support this analysis.

Both demonstrations use ¼" x 0" sawdust as the biomass; and the sawdust comes from similar sawmills throughout West Virginia, western Maryland, and southwestern Pennsylvania. Both demonstrations involved detailed characterization of the coals being burned and the sawdust being burned. This characterization went beyond proximate and ultimate analysis, and included Carbon 13 nuclear magnetic resonance (13 C NMR) studies to evaluate structure, drop tube furnace testing to determine devolatilization kinetics and to produce chars at high temperatures (1700°C or 3100°F) for thermogravimetric analysis of char oxidation kinetics, and other testing to determine the partitioning and speciation of nitrogen in the fuels. Nitrogen testing in the coals included Nitrogen 15 NMR testing as well as pyrolysis characterization of the fuels and chars.

Both projects involved construction of materials handling systems that included fuel receiving, fuel screening, fuel storage, and then transport to the boilers. Since both demonstrations permit the use of 10 percent sawdust (mass basis), the methods of fuel introduction into the boiler varied. The Albright project involves separate injection of the sawdust into the fireball within the furnace. The Willow Island project blends the sawdust with the coal and TDF on its way to the coal bunkers. The Albright project relies heavily upon pneumatic systems for materials handling; the Willow Island project relies heavily upon mechanical conveying of sawdust, and does not use pneumatic systems.

Both projects then involved significant testing for NO_x emissions as a function of fuel blend, load, and excess O_2 as well as the operation of other NO_x control systems. This testing leads to consideration of the mechanisms involved in NO_x control associated with cofiring, including impacts on local stoichiometry, volatile release, nitrogen species evolved in the volatiles (NH_3, HCN, NO) and the volatile/char split associated with the nitrogen in the fuel.

This paper reports the results of testing at both locations, focusing upon the impacts of cofiring on NO_x control. It presents the fuel characteristics, the emissions results as a function of combustion conditions, and then evaluates potential global combustion mechanisms associated with the formation and reduction of NO_x emissions at each location. It relates these NOx emissions results to previous tests at Bailly Generating Station of Northern Indiana Public Service Company (NIPSCO), Seward Generating Station of GPU Genco (now Reliant Energy), and the Allen Fossil Plant of the Tennessee Valley Authority (TVA).

In addition to NO_x emissions, cofiring can impact other environmental considerations of coal-based power generation. This paper reviews such impacts, again drawing comparisons to the tests at NIPSCO, GPU Genco, and TVA.